TOWARDS BUILDING AN INTELLIGENT SYSTEM BASED ON CYBERNETICS AND VIABLE SYSTEM MODEL

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Abstract

It aims to revisit some notable ideas in cybernetics namely, Stafford Beer's viable system model (VSM) and Ross Ashby's Law of requisite variety. In the paper we will discuss the philosophical underpinnings and theoretical standpoints of these ideas and their relevance to the management of a complex engineering organization.

The approach adopted combines cybernetics and systems thinking to explore the key parameters to building an intelligent system. We take an Intelligent system-to be ~~a~~ viable and one that can learn and adapt to the changes in its environment.

CSTP-NASRDA [Centre for Space Transport and Propulsion – National Space Research and Development agency] is used as an example to explore how a complex engineering organization can become viable enough to cope with the dynamics and complexities that confront management. The more complex an organization gets the more complex it is to manage hence, the more organization we have to put in. In this paper, a model for an intelligent system is built, based on Stafford Beer's viable system model and Ross Ashby's contribution to cybernetics.

Keywords: system, organization, intelligence, viability, Viable Systems Model, and cybernetics

Introduction

To remain viable an organization needs to have capacity to adapt to new situations. This capacity for adaptation is normally associated with the strategic levels of management in an organization (Espejo & Harnden, 2006). In exploring this field of study, we ask the question; how can policymakers increase the likelihood that everyone in the organization will contribute, to the best of their abilities, to the decision-making process necessary for an effective organization? (Espejo & Harnden, 2006, p.83).

In this paper, we use the Centre for Space Transport and Propulsion; one of the activity centres of National Space Research and Development Agency (NASRDA-CSTP) as an example for building an intelligent and viable system model. CSTP-NASRDA is Complex engineering organization with a strict engineering environment for scientists and engineers (highly systematic and reductionist in its approach); this work therefore, suggests that, a systemic perspective can help reduce complexities and improve the way decision processes operate/are made.
We discussed system thinking as a basis for justifying cybernetics as an advantageous systemic approach to our situation of interest. However, in order to reaffirm the importance of critically informed research, the application of cybernetics to problem definition or situation of interest was used. The purpose of this paper is to introduce VSM as a recommendable and useful model for complex engineering organization's management; directed at making it a viable system. VSM is a product of cybernetics; ‘’the science of control and communication of complex and dynamic systems (living system, machine or organization) (Wiener, 1962). Cybernetics has evolved over the years with notable contributions from Warren McCulloch, Walter Pitts, N. Weiner, Donald Hebb, Ross Ashby and Stafford Beer (Abraham, 2002) (Beer, 1995)(Wiener, 1962)(Espejo & Harnden, 2006). Stafford Beer however, contributed to cybernetics by introducing it to management, which became the basis for the model he described as viable systems model (Beer, 1995) (Beer, 1979). It also moves towards building a model based on Ross Ashby's law of requisite variety and Stafford Beer's viable system model to

help CSTP-NASRDA adapt to the changing environment (Ashby, 1958; Beer, 1995; Espejo & Harnden, 2006; Schwaninger, 2019).

We begin by exploring the situation of interest or problem space, which is a complex engineering organization. ‘’Problem definition is often considered a project’s most important and difficult phase’’ (Stephanie, 2012). The definition of the problem space is a critical phase of a research because, the ontological perspective has to be met with a corresponding and appropriate epistemology, which all together shape the approach of inquiry and methodology. A complex organization is that which has multiple processes that interact with the changing environment and requires simultaneous management. In a bid to meet this requirement, we explore key parameters to building an intelligent system that possess considerable amount of viability and can adapt to the changing environment. ‘An intelligent system is that one that learn and adapt to be viable’ (Nora, Slimane, 2018; Schwaninger, 2019). After the exploration of this key parameter, we move to building an intelligent system model to help management cope with the dynamics and uncertainties associated with a complex engineering organization.

Objective
To reaffirm the importance of critically informed research: An intro to cybernetics; systems thinking and their philosophical underpinnings.

Critical evaluation of problem definition or situation of interest.
To revisit cybernetics and VSM as useful tools to building an intelligent system/organization.

To synergize the contribution of Ross Ashby’s Law of requisite variety and Viable System Model (VSM) for the development of a cybernetic model specifically for complex engineering organization such as CSTP-NASRDA.

Systems thinking and cybernetics in perspective

Systems thinking is also about interconnectedness (Stowell & Welch, 2012). Its basic building blocks can be subsumed as ‘Emergence, Hierarchy, Communication and Control’; therefore, if the management of an engineering organization adopts this framework of reasoning, then, it becomes possible to improve decision making and resolve problems without causing adverse resultant effect elsewhere within the organs of the organization (Stowell & Welch, 2012).

Cybernetics however is a type of systems thinking as it is also about interconnectedness and thinking in a systemic way (Dorfman, Meyer, & Morgan, 2004). The interconnectedness and interdependence of all living systems, phenomena, organization, and behavioural patterns is the central principle of cybernetics. Systems thinking and cybernetics unequivocally view all the entities and subsystems within the system as interconnected and that an effect on one will ultimately have a resultant effect overall. This line of reasoning is an improvement on the classical science of cause-and-effect because it is a holistic approach (Dorfman et al., 2004). Nevertheless, cybernetics is subsumed into different orders: first order cybernetics focuses on an 'observed system' while the second order cybernetics is about 'observing system', which also takes into account the observer (Baron, 2007). Simply put, the first order is similar to the classical science approach while the second order according to Von Foerster is considered to follow a non-classical scientific rational (Foerester, 1974; Lepskiy, 2018). The third order cybernetics is what can be referred to as the point where it overlaps with systems thinking as it combines first and second order cybernetic approaches dealing with the self-reflexive-active environment (Lepskiy, 2015). Cybernetics has however evolved over the years with major contributions from Walter McCullock, Warren Pitts, N. Weiner, Ross Ashby and Stafford Beer (Beer, 1995). We now have management cybernetics, medical and biomedical cybernetics; cybernetic knowledge of neural networks etc. (Pekker & Novikova, 2014; Smurro, 2018). However, this paper focuses on management cybernetics.

Origin of cybernetics and its important to building an intelligent system

The origin of cybernetics can be traced back to Aristotle; the structure of knowledge itself and the principle of non-contradiction, which then evolved to become syllogism (the basis of reasoning). Aristotle's law of non-contradiction explains that you cannot be 'A' and 'Non-A', however, you can be something between 'A' and 'Non-A' (Beer, 1979, 1995; Stanford Encyclopedia of Philosophy, 2015).

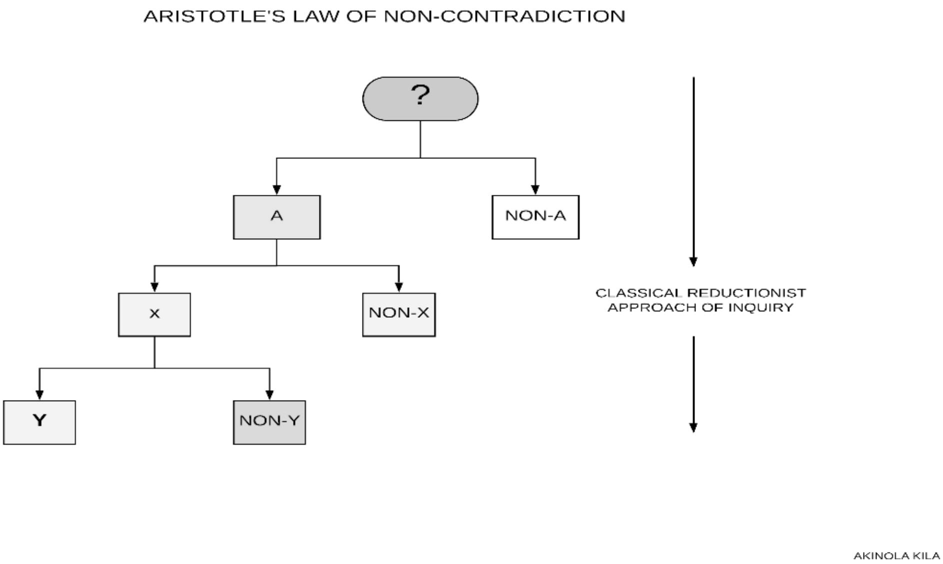

Figure 16 graphical illustration of law of non-contradiction

The figure 1 above looks like a family tree and that is what a reductionist approach means from the law of non-contraction.

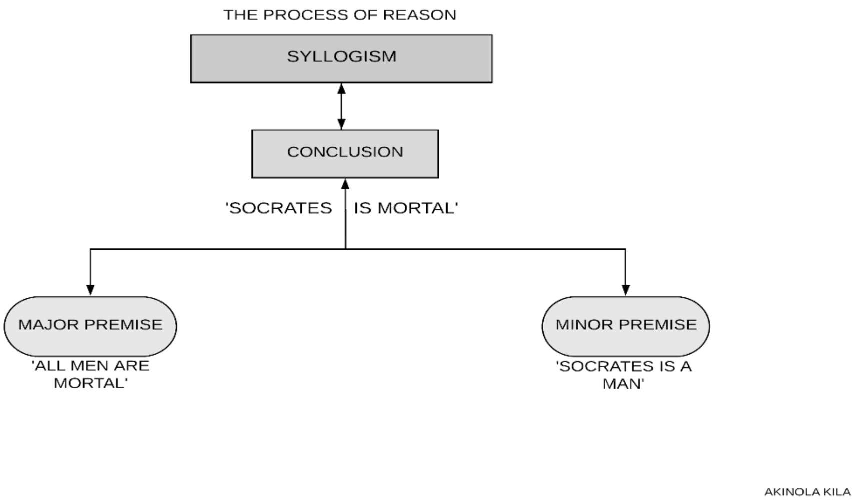

Figure 17 graphical illustration of syllogism

This develops again with Aristotle with syllogism as the process of reason just as shown in figure 2 above; which as to do with making conclusion based on major premise and minor premise. The classical one for example is ‘’All men are mortal’’, and a minor premise, ‘’Socrates is a man’’, we then deduce that ‘’Socrates is mortal’’. This became the basis of reason and classical science; it is what we refer to as a reductionist approach of inquiry.

However, in building an intelligent system, one must seek to explore non-reductionist approaches like cybernetics for a process of reasoning that perceives thing in a holistic way; with a better reception to handling complexities and uncertainties. This approach has already emerged in different fields of study, such as in physics ‘relativity and uncertainty’ and in biology ‘autopoiesis’(Beer, 1995).

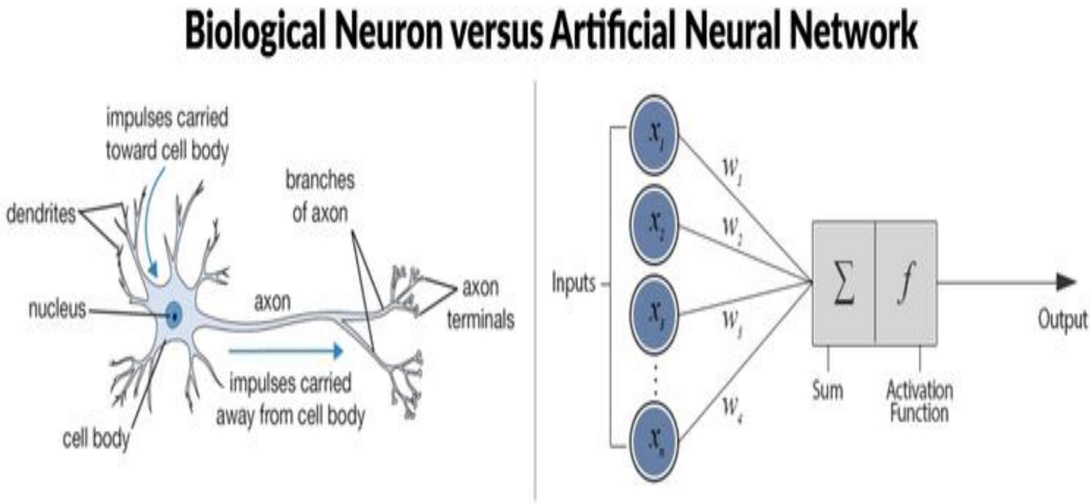

Figure 18 showing evolution of neural network from biological neuron

As shown in figure 3 above, one of the earliest Cybernetician was Warren McCullock, who was also a Neurophysiologist. In 1943, he developed a neural network circuit from studying how neurons in the brain works with his friend Walter Pitts (Mathematician) (Abraham, 2002). The diagram illustrates how neurones receives input via the dendrites; processes it in the nucleus by adding a neuro-transmitter, it then gets transmitted via the axon that converts it back to an electric signal which outputs through the axon terminals that connect to multiple dendrites of other neurons or to a muscle for effective action through the central nervous system. This biological phenomenon became the basis of neural network design and method of taking in multiple inputs and processing it with an 'activation function' before outputting it. Contribution was also made to this work by Donald Hebb who explained by pointing out, how neural networks are strengthened anytime they are used. A conceptual framework that is fundamental to how the human brain learns. If two nerves are activated at the same time, he argued that the connection between them is enhanced (Hebb, 2002). This evolution of neural network from biological neuron is a cybernetic framework of thinking that has also enhanced the pursuit of artificial intelligence.

It is therefore appropriate to describe cybernetics as an interdisciplinary subject of interconnectedness and a super-science of system's control and communication. A science of purposeful system and effective organization

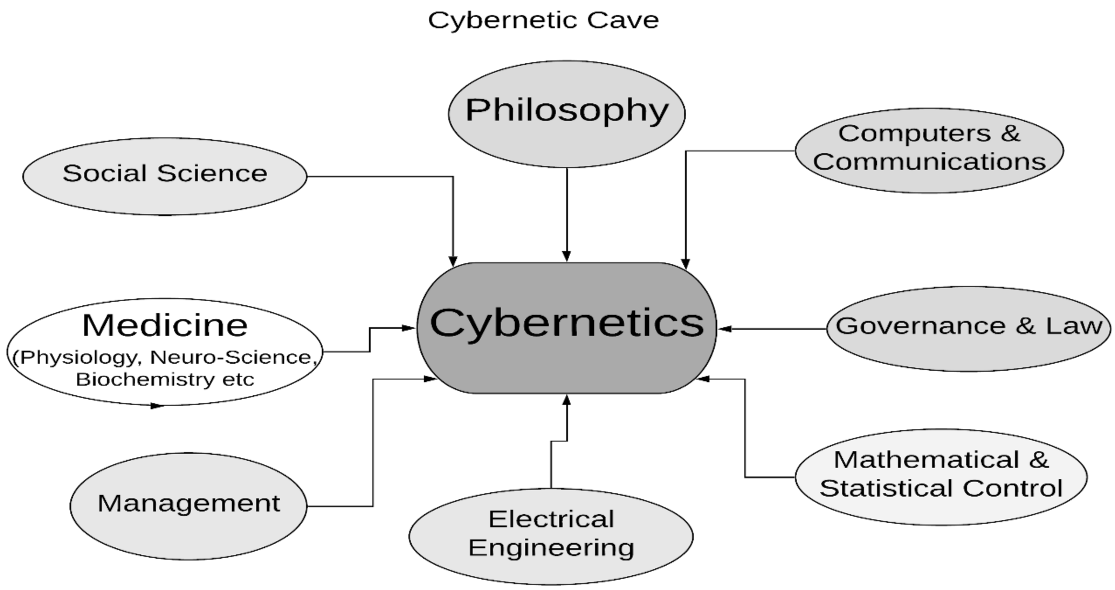

Figure 19 Cybernetics and different disciplines of influence

Figure 4 above shows different disciplines of study that have influence on cybernetics and also where cybernetics can be applied. Cybernetics is the approach that made the digital age possible (Beer, 1995). Beer illustrates that cybernetic answer is structural (Beer, 1995, P.21); that the structural architecture and arrangement of semi-conductors is what is responsible for the computational power of computers' processor and RAM management; not just because it is silicon-based semiconductor. On the same basis, the structural arrangement of amino acids in the DNA of a living cell is what is responsible for its genetic powers and not just because it is protein.

Some of the key definitions of cybernetics can be summarised below:
''Cybernetics was defined by Norbert Wiener to be the field addressing communication and control in animal and machine'' (Wiener, 1962).
''Ashby indicates that cybernetics can be applied to many systems including biological organisms, anthills as functioning societies, and economic systems. He wrote "Prominent among the methods for dealing with complexity is cybernetics"(Ashby & Young, 1961).

Heylighen and Joslyn write: "Cybernetics is the science that studies the abstract principles of organization in complex systems. It is concerned not so much with what systems consist of, but how they function. Cybernetics focuses on how systems use information, models, and control actions to steer towards and maintain their goals, while counteracting various disturbances'' (Heylighen & Joslyn, 2001). The focus on control that is organic; which can also be modelled for systems stability, viability and improved productivity of a purposeful system is the basis of Stafford Beer's viable systems model (VSM). VSM specifically provides basic structural configuration for viability. With VSM, an organization is set to be viable only if it commands a set of management subsystems, functions and interrelationships of which they are defined precisely. Just as Meadow right quoted ''Stop looking for who is to blame; instead start asking, what is the system? (Meadows & Wright, 2008)''.

The contribution by Stafford Beer to cybernetics in his design of the VSM was as a result of understudying the sympathetic nervous system of human being and its viability, which can then be modelled for management in an organization. This concept of cybernetics with emphasis on structural arrangement was introduced to management for effective control and enhance viability of organization (Beer, 1995). VSM however, focuses on system structure as a computable function of purpose.

Beer’s viable system model in focus

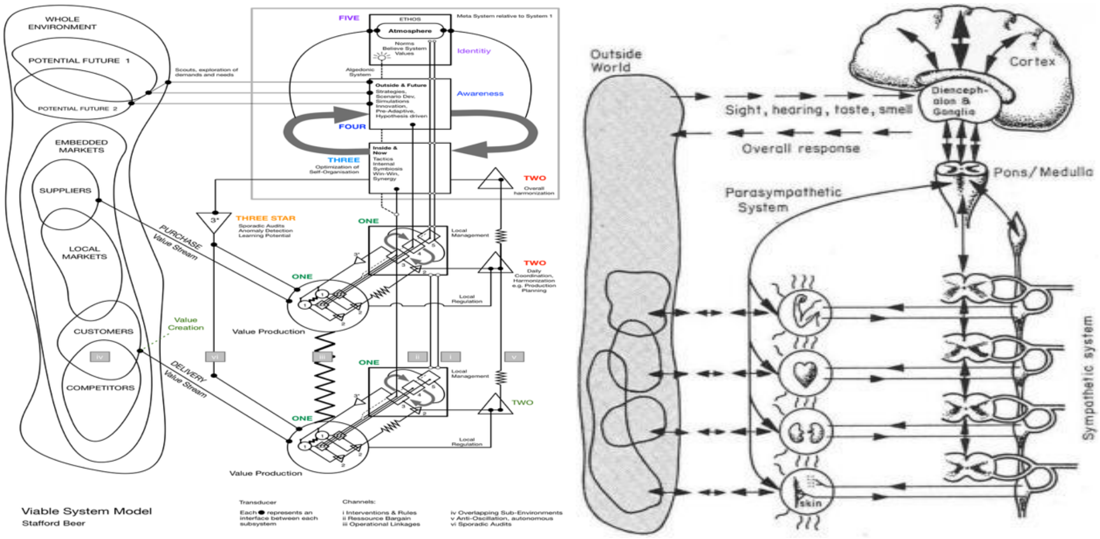

Figure 20 VSM and Sympathetic Nervous System

The figure above is a graphical representation of Beers viable systems model (VSM) for a customer-based production company based on human’s sympathetic system (Schwaninger, 2019). This model is based on the assumption that current system’s structural control is ‘benign’, which means localised. The word ‘Benign’ itself is inimical to viability (Beer, 1995, p.21). It is inspired as a reflection of the human autonomous nervous system; because it is capable of operating without any conscious intervention just as the case of VSM (Beer, 1995). The study of the sympathetic nervous system shows how different parts of the brain controls all the organs within the body; at the same time interacting with the outside world simultaneously, just as shown in the image on the right in figure 7.

Critique of VSM

In the literature on VSM applications, rarely any account of failures have been published, nevertheless, the practical applications and ease of use have raised some discussions(Jackson, 2005; Schwaninger, 2018). However, the model conveys a conceptual framework for design and diagnosis of organizations viability with respect to the principles of decentralization, participation, autonomy and ultimately democracy. The model possesses a methodological rigor: It offers a well-grounded and justifiable structural framework for dealing with complexity (Schwaninger, 2018).

Beer himself reflected upon some of the perceived limitations of VSM. How the theory is affected by the notion that the basic parts of a social organization involves purposeful people with free will, rather than organs or cells with no free will. Beer addressed this with the principle of recursion as the organizational maxim (Espejo, Harnden, 1989; Schwaninger, 2018). Simply put, the viability; cohesion and self-organization of the firm, divisions and subsystems are structured recursively and they are driven by a social rule of conduct which is called the autonomy of purpose (Beer, 1995).

In our research to building an intelligent system model for CSTP-NASRDA, we discovered that that the theoretical understanding and application of Ross Ashby's law of requisite variety was pivotal and not just the duplication of Beer's VSM. We also explored where necessary the law of cohesion by Beer in designing the model for variety attenuation and management.

Key laws to building viable and intelligent system model

For a system to be considered viable, it must be capable of independent existence. However, nothing is capable of absolute independence as every individual/system still needs something from its environment (Beer, 1995; Espejo, Harnden, 1989). Hence, the viability we are trying to achieve is not absolute but reasonable enough, in order to achieve an intelligent system that can survive on its own, for a considerable period of time before any major action is taken. There are two key laws we considered in this work to building a viable system which can be subsumed into:

- Ross Ashby's law of requisite variety: which states that only variety can absorb/nullify variety; also, we cannot effectively control everything within a system, hence we choose what to control effectively (Ashby, 1958; Stowell & Welch, 2012; Young, 1961).

- Law of cohesion by Stafford Beer: which states that in a viable system, just as much variety attenuation is needed to maintain a balance within the system (Beer, 1995; Espejo, Harnden, 1989).

It is worthy to note that, ‘variety’ in relation to Ashby’s law of requisite variety is the option/variables presented at any time by the situation of interest or controlee; and it is directly proportional to complexity. This means that the more the variety, the more complex it is to control the system. Variety or complexity must then be met or absorbed by options presented by the control system/mechanism. This was elucidated by Ashby’s statement that says ‘all processes of regulation are dominated by the law of requisite variety; and that if a certain quality of disturbance is prevented by the a regulator from reaching some essential variables, then that regulator must be capable of exerting at least that quantity of selection’(Ashby, 1958; Stowell & Welch, 2012). Ashby further explained that if we choose to control everything within the system, it would not be effective; hence, we should choose what to control effectively (Ashby, 1958).

However, in order to demonstrate the building of an intelligent system for effectively managing complexities based on the laws above, we explored the organizational structure of Centre for Space Transport and Propulsion, which is one of the centres of National Space research and Development Agency (CSTP-NASRDA); generally called the Nigerian Space Agency and overseen by the National Space Council of Nigeria.

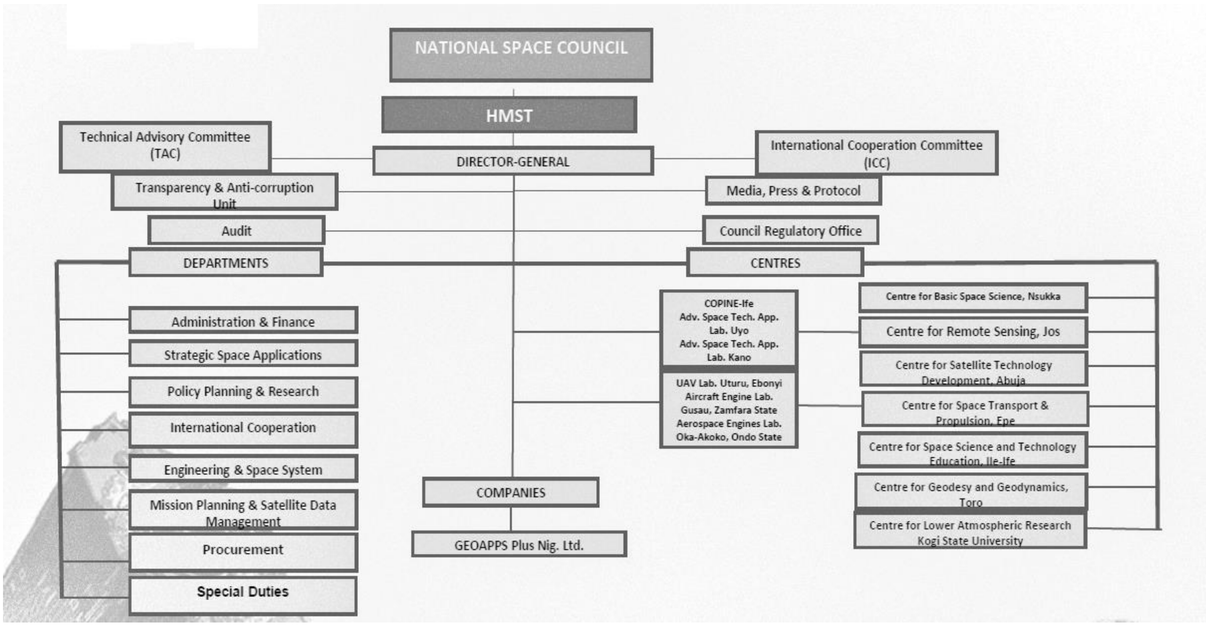

Figure 21 Current NASRDA's Organogram

Figure 6 above is an organogram that shows the current hierarchy-based structure of NASRDA and CSTP as one of the activity centres.
We viewed this centre (CSTP) under the lenses of VSM and Ashby's law of

The purpose of CSTP is research into rocketry and unmanned aerial vehicles (UAV); and its primary activities, which we can also refer to as internal environment can be subsumed into four main processes and sub-systems namely:

- PROCESS A – PROPULSION SUB-SYSTEM
- PROCESS B – STRUCTURES SUB-SYSTEM
- PROCESS C – AVIONICS SUB-SYSTEM
- PROCESS D – DESIGN & COMPUTATION SUB-SYSTEM

Furthermore, the existing structure of this organization as shown in figure 8 below; is a reminiscent of the reductionism-like family tree explained earlier in this paper in the Aristotle's law of non- contradiction.

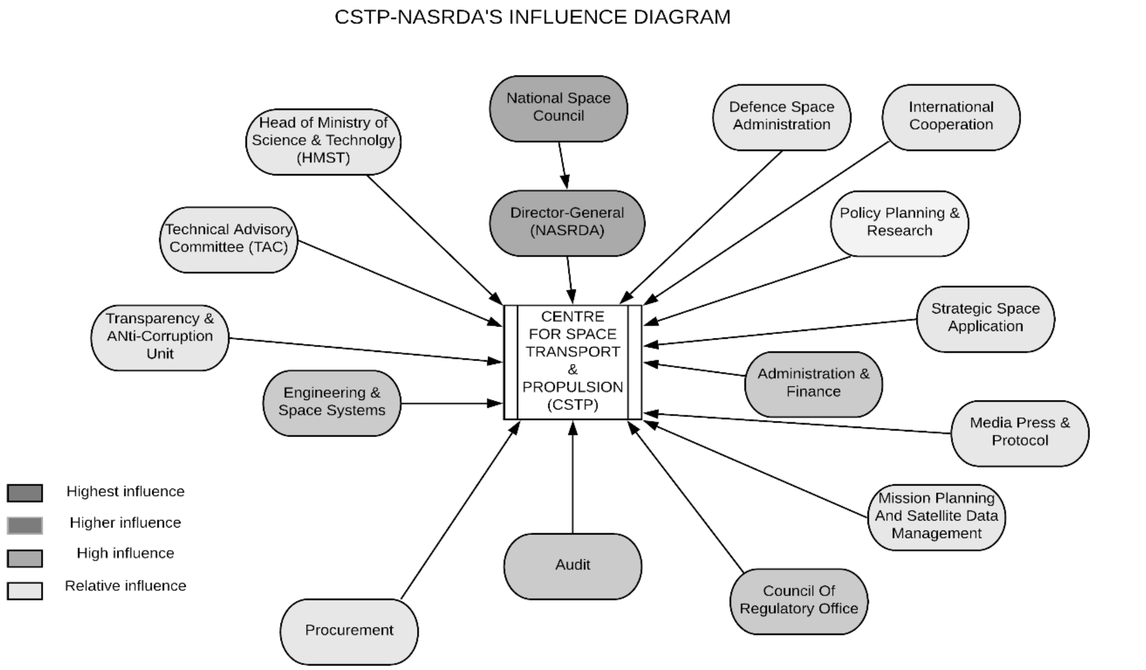

Figure 22 Showing CSTP-NASRDA influence diagram

Nevertheless, the sources of complexity in an organization like this are external environment; internal environment and policy (Espejo & Harnden, 2006). Hence, the reason for the introduction of key structural filters and control mechanism to manage these complexities and effectively control the sub-systems respectively, in order to make the system viable. Notably, we are only exploring one of the centres of NASRDA known as Centre for Space Transport and Propulsion with key interest in its environmental boundary and the influences exerted on it.

For further investigation into CSTP-NASRDA's boundary, we drew an influence diagram to show for illustration as shown in figure 9 below:

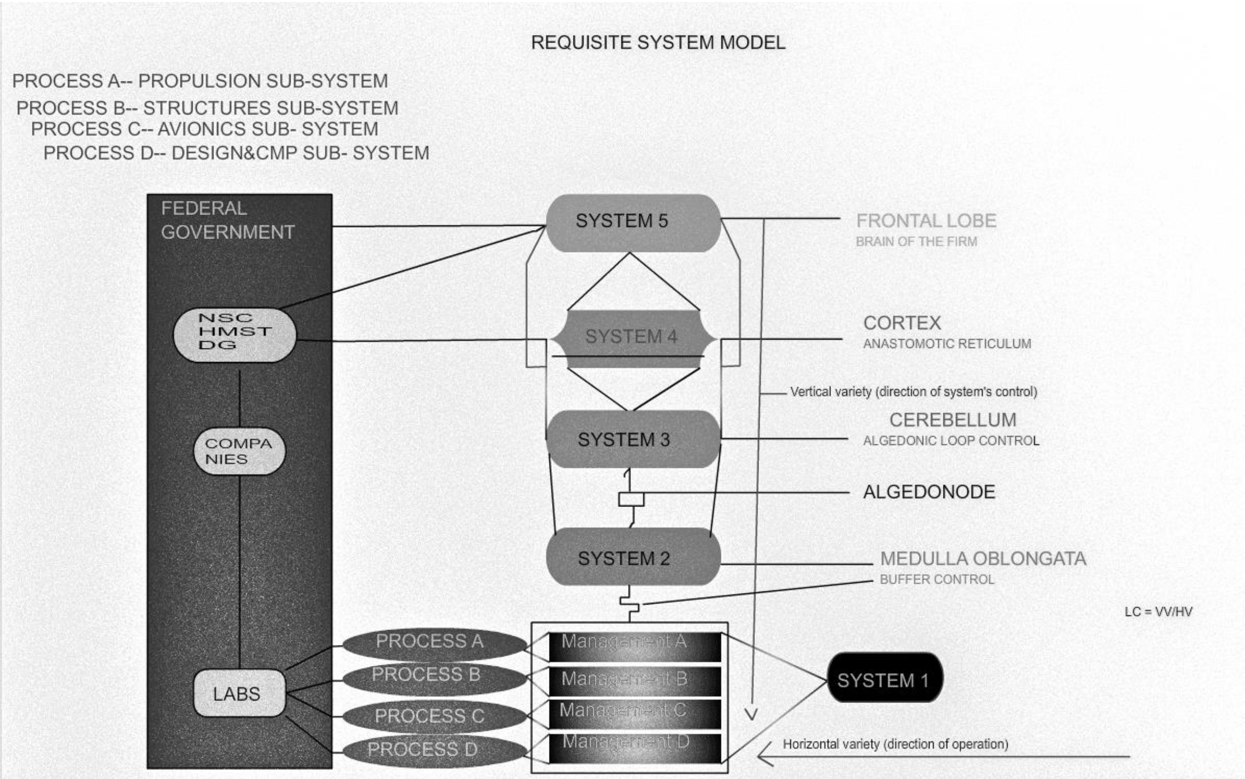

Figure 23 intelligent system model for CSTP-NASRDA

Figure 7 above shows other entities within NASRDA which are outside the system boundary of CSTP but have influences on it. There is a colour coding from highest influence to the relatively low influence. We proceed to building an intelligent model specifically for CSTP within its NASRDA's environment.

Intelligent system model for cstp-nasrda

The above diagram (figure 8) shows the graphical representation of the key structural filters and control systems for CSTP-NASRDA. In this model, we began by identifying the key components within the system. We have the environment; process and the management. These three components make up the primary structure of each sub-system within CSTP-NASRDA. For process A, the lab is an example of the environment and management A is the control mechanism for the process. Correspondingly, the produce: Environmental Variety; Process Variety and Management Variety. This is where the problems are generated, and this is why we designed 'system 1' to attenuate this complexity. However, for consistency of lexicon in this paper, the measure of complexity in cybernetics is called 'variety' (the number of possible states of a system (Beer, 1995)). We can deduce from our epistemology that variety of management is lower than the variety of process (meaning that management cannot simply know everything happening, hence cannot effectively manage it), also process variety is lesser than the environment variety (Shown in figure 9 below), the variety of each management is less than that of the corresponding process and environment respectively.

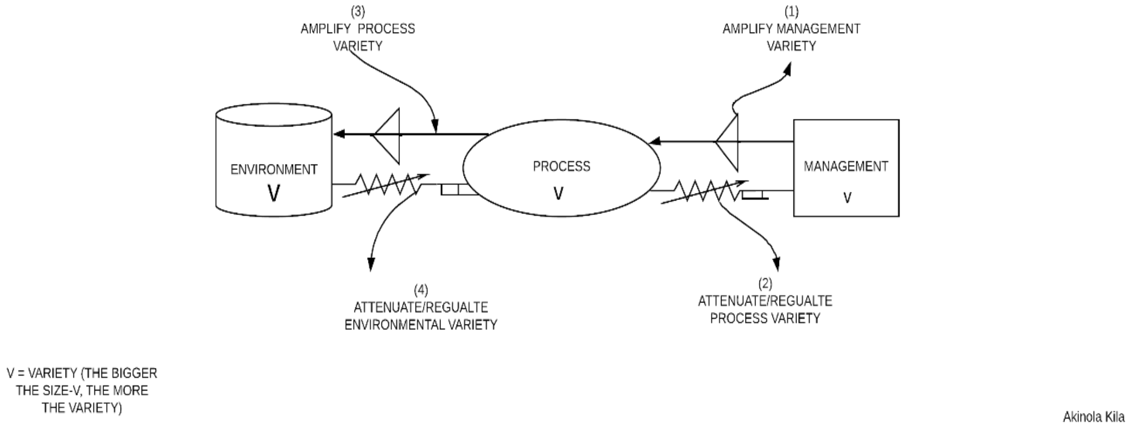

Figure 24 illustration of variety attenuation and amplification

In the above diagram, we showed how we can amplify/attenuate management's variety to meet the process variety and how the process variety can be amplified/attenuated to meet the environment's variety respectively. More so, management needs to increase its variety in a bid to meet the process variety for example by providing training schemes, putting up health and safety measures. At the same time, the process variety needs to be controlled and decreased with an attenuation mechanism. Respectively, the process variety has to be increased to meet the environment's variety; for example, increasing the advertising/media presence, market or laboratory research (Beer, 1979, 1995).

This control system helps the management regulate the processes within an environment. Managements A – D have to communicate with processes A – D; and the processes have to communicate with the environment with regards to what they do. Also, there is a return loop where the environment returns communication to the process and then it reports back to the management (eg. We are doing what you asked us to do). It is worthy of note at this point that, the old reductionist managerial way of measurement, which was largely regarded to as the four 'Ms' namely: Men, Materials, Machinery and Money; we have now reclassified it as 'complexities' (Beer, 1995). The holistic and uniform commodity underlying the common problems of the four ‘Ms’ is regarded as complexity in this organizational management. Simply put, the more complex it gets the more complex it is to manage, hence the more organization we have to put in. This model is devoid of this exponential variety by introducing corresponding system’s control.

Furthermore, we aggregated the key sub-systems process in the model to illustrate their interconnectedness with both their management and the environment. The control systems which we have designed is explained below:

At this point, we introduce Ross Ashby’s law of requisite variety that states ‘only variety can absorb variety’; the explanation and modelling we have been making earlier in system 1 is an organization of Ashby’s law of requisite variety. It is like law of nature, either we organize it or not, it will exert itself. Hence the need to organize it in order to prevent chaos (Ashby, 1958; Beer, 1995). When variety is constantly generated, by Ashby’s law, the situation will always absorb the variety one way or the other. So, what we tried to do in system 1 is to organize the system by getting requisite variety beforehand in other to manage imminent complexities generated from varieties to prevent chaos (Beer, 1995).

System 1

The procedure we explained above is a building block of a complex organizational system, which its environment, processes and management are interconnected. We also showed how to manage variety and prevent chaos. As shown in figure 11, these are the sub-systems/divisions of CSTP-NASRDA. It is not a hierarchy, sub-systems A to D can be placed whichever way. In system 1, we are introducing viability to the four sub-systems. Before we explain how this works, there is need to define what a viable system means. A viable system is that which is capable of independent existence. Not that anything is capable of absolute independence existence, because every entity and systems will always need something from its environment; however, we are referring to a significant amount of independence that would make it viable. Even if a part of the system is having problem, it would not be detrimental to the whole before addressing it.

System 2 (Medulla Oblongata)

What we have explained in system 1 in relation to managing variety, can be considered as the introduction of horizontal variety in other to have requisite variety in managing the horizontal interactions between management, process, and the environment. Because managing horizontal variety can be a difficult task to maintain; there is need to generate a vertical variety to create balance in the sub-systems' management and improve their viability. We have tagged this the 'Buffer control' because, just like in chemistry, we use buffers to balance the pH level – from either being too acidic or basic to neutrality. There are also catalysts or enzymes in natural sciences that serve similar purpose of balancing rate of reactions but do not necessarily partake or get involved in the process of reaction.

However, we refer to system 2 as the medulla oblongata because it is at the lowest part of the brain which houses the control centres for the heart, lungs etc. it is primarily responsible for autonomous function within the body such as, breathing, sneezing, heart rate monitoring, etc. (Hornby & Turnbull, 2010). It is what houses our buffer control of autonomous system in this model. What we are doing with the buffer control it is to an extent, taking and given variety away from management of the sub-systems which might seem inefficient; hence the need for a cohesion and synchronization of these stages. This is the stage where we require Beer's law of cohesion that states '' in a viable system, just as much variety attenuation/reduction is required to keep the identity of the whole intact''. Therefore, for a viable system to be balanced it requires as much variety attenuation both horizontally and vertically. Law of cohesion = VV/HV (vertical variety/horizontal variety). To reiterate, the purpose of the model, is to make each subsystem viable and at the same time interconnected with the whole; hence these principles and laws are universal to the management of each system control. In addition, the variety attenuation and cohesion we are using especially in system 2, to balance oscillation within system one is not an oppressive control, but a strategic division of managerial task and the encouragement of the autonomy of a purposeful system. The purpose of the system must be the driving motivation/force of this intelligent system. To become a viable system, requires service of purpose, just like in autopoiesis. However, the main reason why this strategic and dynamic system's control is vital is to prevent the pathology of management that can arise when sub-system tend to seek absolute viability (Beer, 1995).

In addition, in a bid to minimise the reduction of varieties; and because of the massive amount of varieties constantly generated in complex organizations like this or just because of how inconsistent humans can be there is need for system 3.

System 3 (Cerebellum)

The rate of change within the system control can be inevitable, hence the need for system 3. We can simply describe this stage of management control as crises management. This phase of the system control does not have the luxury of time to think as the emergent varieties generated within the system has to be met immediately by Ashby's law (Beer, 1995). For example, there is an unsolicited visit of the press to the organization demanding key information about the processes or system 2 simply broke down and there must be an instantly response. We refer to system 3 as the Cerebellum because it is the part of the brain that regulates muscular activities and respond to stimuli (Hornby & Turnbull, 2010). System 3 must also be in considerable awareness of the happenings within the processes.

System 4 (Cortex)

System 4 takes charge of varieties, which are not in crisis or require emergent response. It is in constant interaction with the system boundary/environment. It syncs the flow of information between the organization; its environment and entities that have influences of it within its boundary. It is worthy of note that the outside world to the whole system is more than the sum of the system's environment; and there is an emerging future in the environment that the system constantly needs to be aware off. So, imbedded in the system's environment, there is both the present and future environment which is emerging, and an intelligent system must be aware of it. In order for us not to be trapped by Aristotle's law of non-contradiction, where we have to then either be system 3 or 4, we designed a loop around them for continuous information synchronization. This loop (from System 3) was referred to by Beer as the 'Algedonic loop' (Beer, 1995). An organization that does not balance this loop can lose its viability. This is the stage where it balances investment in relation to future plans. The loop between system 4 and 3 is what will actually make the system intelligent enough to adapt to ever dynamic/changing environment/world. System 4 is what we regarded as the cortex because, just as in the autonomous nervous system, it is capable of operation without conscious intervention (Beer, 1995; Hornby & Turnbull, 2010). It is also what Beer refers to as the anastomotic reticulum (cross connection between vessels or network (Hornby & Turnbull, 2010)) in his book 'Brain of The Firm' (Beer, 1995).

System 5 (Frontal Lobe / Brain of the firm)

The role of system 5 which happens to be the final system control is monitor and maintain the balance within system 4 and 3 known as the loop for adaptiveness for dynamic environment. We refer to system 5 as the frontal lobe because it is at the end of the brain just behind the forehead which the primary role is to coordinate behaviour, personality, voluntary behaviours and learning (Hornby & Turnbull, 2010). This final control system is what is responsible or policy formulation and also expresses the identity of the organization. It is the final part of the brain of the firm.

Sensorium for transfer function and decision making

See following Fig.

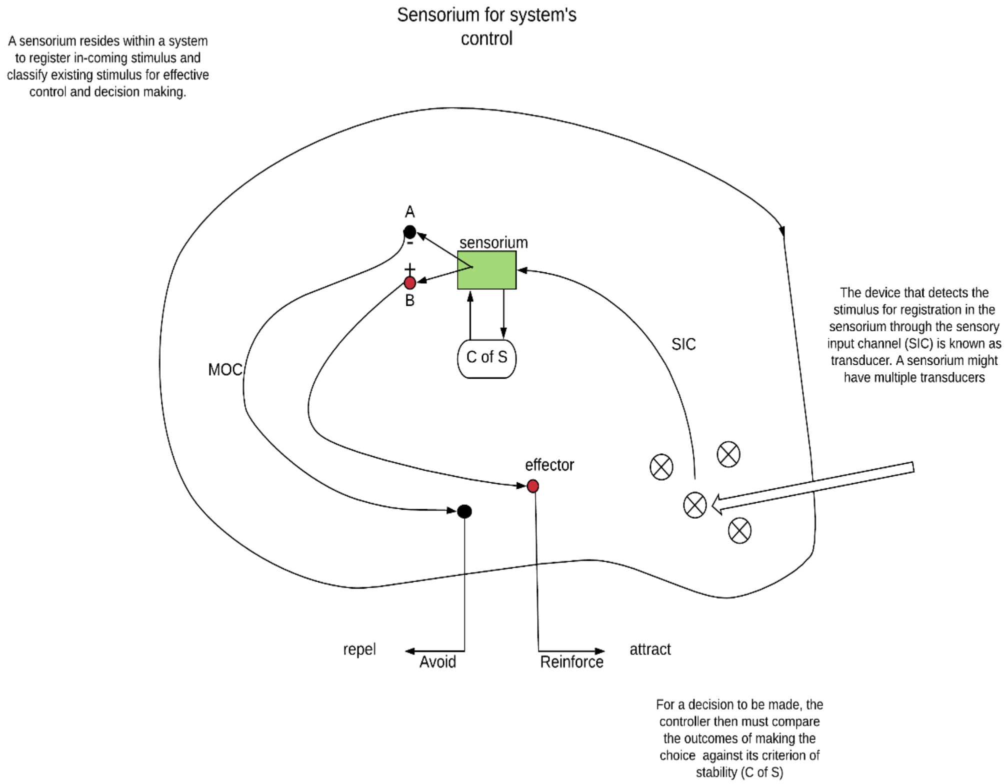

Figure 25 Illustration of sensorium for transfer function and decision-making

The sensorium resides within a system to register in coming stimulus and classify existing stimulus for effective control and decision making (Beer, 1995). The sensorium is a cybernetically inspired means of addressing transfer function and decision making without having to mathematically model it. Every system must possess a form of sensorium to become stable. In this case we have a transducer; which is a device that detects the stimulus for registration in the sensorium input channel (SIC). A sensorium might have multiple transducers connected to a single sensorium. When a stimulus is detected, it goes through the sensory input channel (SIC), into the sensorium; and for a decision to be made, the controller then must compare the outcomes of making the choice against the criterion of stability (C of S). This then gets passed out via the motor output channel (MOC) as an effector to either be repelled; reinforced or maintain neutrality as the case may be (Beer, 1995).

Conclusion

This model has shown that an intelligent system must be viable centralized or decentralised system; that they have to be fused and approached in a systemic way that intelligently connects all the organs within the system just like in the autonomous nervous system which is capable of operation without conscious intervention.

However, the focus of this work is not just to build an intelligent system that is viable enough to adapt to the ever-dynamic environment/world. It is also not just about independence or autonomy of sub-systems in terms of absolute freedom, because that will result to chaos but to encourage autonomy of purpose with effectively dynamic control mechanism. We aim to reduce some of the mathematical tools of reductionist approach which includes differential calculus. When we first started thinking in cybernetics about the nature of intelligence, we can write differential equations such as in the case of control engineering or neural networks that varies the output over the input: $f(p) = O/I$. However, in a social-technical system, either studying the way cells behave in the brain as a neuro-physiologist or behavioural patterns of humans as a psychologist; we simply cannot quantify a transfer function. The structure of a viable model for a social-technical system is a computable function of purpose (Beer, 1995). It is a model designed specifically to handling human affairs.

In conclusion, with the advent of social media; internet of things and artificial intelligence; we have had massive distribution of information and organizations; as a result of this, more complexities are being generated. The question then beckons, can VSM be of used in addressing this situation?

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